

Shape Morphing Adaptive Radiator Technology (SMART) for Variable Heat Rejection

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HAT: 14.2.a, 12.3.a TA: 14.2 thermal control – variable geometry radiator

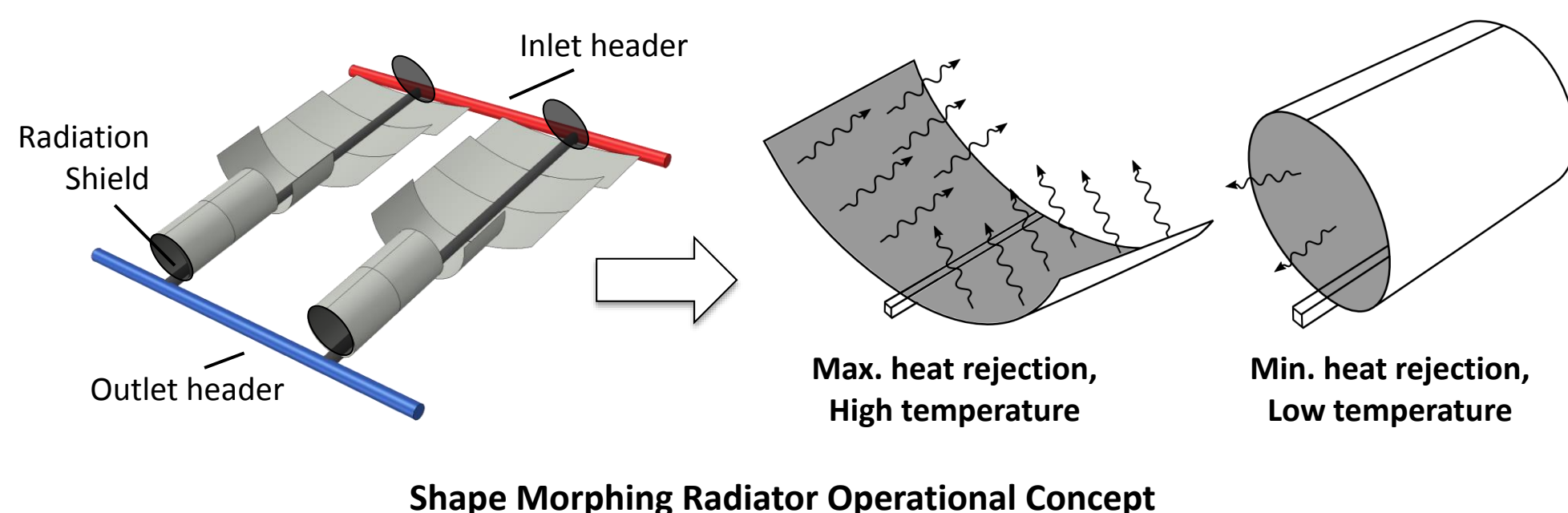
TRL: start 2 / current 3

OVERVIEW

The proposed technology leverages the temperature dependent phase change of shape memory alloys (SMAs) to drive the shape of a flexible radiator panel. The opening/closing of the radiator panel, as a function of temperature, passively adapts the radiator's rate of heat rejection in response to a vehicle's needs.

INNOVATION

This technology would enable active thermal control systems (ATCS) of manned vehicles to meet the Evolvable Mars Campaign's target for 12:1 heat rejection turndown ratio with a single loop ATCS. This project focused on developing a morphing radiator panel optimized to balance its competing requirements of thermal conductivity, flexibility, and stiffness.



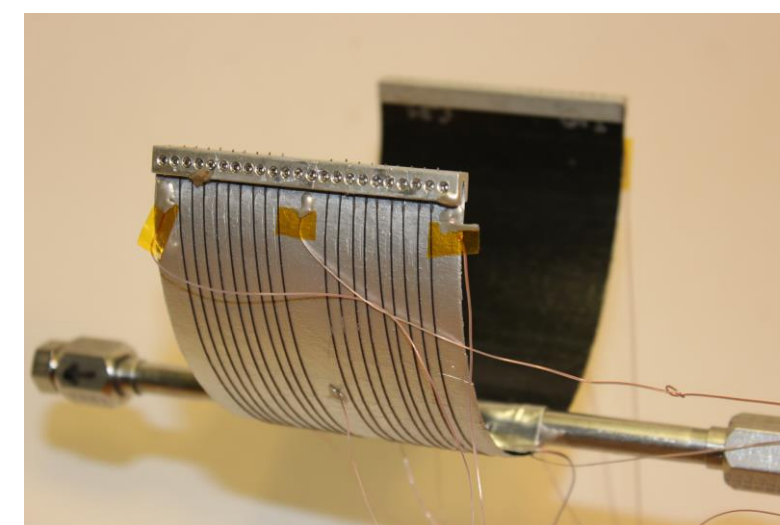
OUTCOME

- Analysis and testing indicated that it is possible to create a morphing radiator with both flexible and thermally conductive carbon laminate panels.
- Demonstrated SMA - driven panel actuation in a laboratory and thermal vacuum environment. 8/2016
- Fatigue testing verified panel design can actuate 100 cycles in ambient conditions without failure. 10/2016

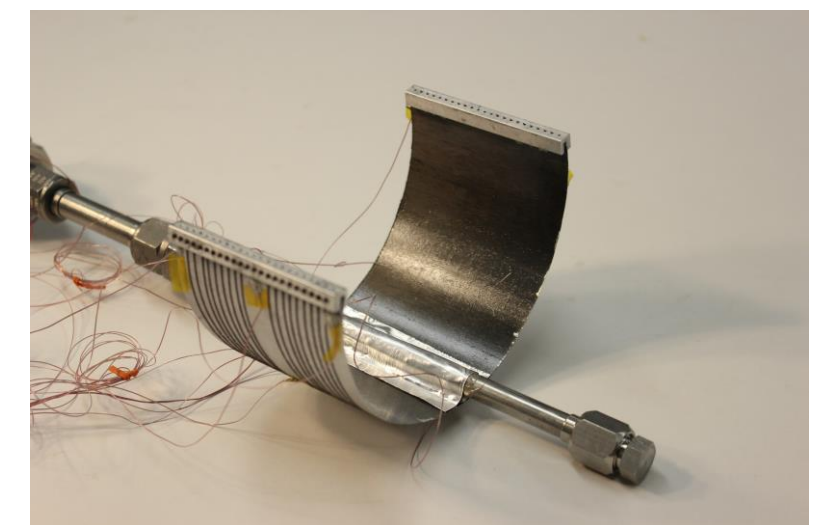
INFUSION SPACE

- Conduct thermal and structural testing to verify multi-panel prototype radiator's design integratory. AES or STMD sponsored thermal vacuum testing can evaluate the radiator's response to transient heat loads expected by a mars transit vehicle.
- A flight demo on an ISS express pallet can demonstrate operation in a space environment.

2016 JSC Technology Showcase



Prototype Morphing Radiator Panel



Thermal Vacuum Test of Prototype Panel



PARTNERSHIPS / COLLABORATIONS

NASA JSC partnered with Texas A&M University professors and student researchers on the development of the flexible composite panel and assembly of the SMAs. JSC materials and thermal engineers provided technical guidance during the design process and evaluated the panel in a representative thermal vacuum environment. NASA GRC provided expertise in SMA formulation and processing.

PAPERS

The following papers will be presented at the 2017 AIAA Science and Technology Forum and Exposition:

- 1) *Design and Fabrication of a Composite Morphing Radiator Panel Using High Conductivity Fibers*
- 2) *Experimental Characterization of a Composite Morphing Radiator Prototype in a Relevant Thermal Environment*

FUTURE WORK

This work will continue as a FY17 center level IRAD project with our current collaborators. Development will focus on creating a practical radiator design that will incorporate both the SMAs and radiator tube in a higher fidelity panel design. Custom SMA development will also be conducted at NASA GRC, addressing the current need to actuate the radiator at temperatures required for future manned spacecraft.